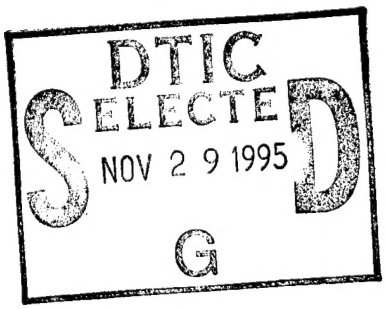
October 1995

DCIEM No. 95-29

THE SPECIFICATION OF USERS AND THEIR ROLES

A.L.M. Donati
D. Beevis



Defence and Civil Institute of Environmental Medicine
1133 Sheppard Avenue West, P.O. Box 2000
North York, Ontario
Canada M3M 3B9

ABSTRACT

Although the approach to systems development varies widely, the overall approach to human factors engineering in military system development is usually specified by US MIL-STD-46855. The approach set out in MIL-STD-46855 emphasizes analysis and reflects the traditional waterfall model of systems development, although there is nothing inherent in the standard to prevent an iterative approach. A review of ten Canadian Forces development projects concluded that the application of human factors engineering, was enhanced by the use of a Human Engineering Project Plan based on MIL-STD-46855. A subsequent survey of approaches used to include user requirements in development projects showed large differences in attitude and practice. The survey identified the need for aids to facilitate the inclusion of users' requirements in the Statements of Requirements. Designers also need to know the context in which their system or equipment will be employed. This is particularly true of personal equipment. Few designers of advanced systems have knowledge of operational conditions and constraints. One development (the Soldier's Day) being undertaken for the Canadian Forces is aimed at providing designers with the context of the roles and tasks that operators perform, as an aid to understanding how equipment will be used.

EXECUTIVE SUMMARY

In the Canadian Forces (CF), Human Factors Engineering (HFE) is a recommended rather than a required activity. HFE is often construed as a hindrance to overall project development instead of being recognized as a key to ensuring a project's overall success. HFE issues are not often considered in the planning process until late in development, if at all, when a human factors related problem is identified. At this point, due to the constraints of the project, there may be little scope for change that is feasible or economical. This paper advocates an earlier consideration of HFE issues than is currently employed. In particular, an early understanding of the users and their roles is urged as a key feature of the overall process.

A review of ten CF development projects concluded that the application of human factors engineering was enhanced by the use of a Human Engineering Project Plan based on MIL-STD-46855. A subsequent survey of approaches used to include user requirements in development projects showed large differences in attitude and practice. The survey identified the need for aids to facilitate the inclusion of users' requirements in the Statements of Requirements (SORs).

In the Department of National Defence (DND) acquisition process, users are not accessed directly but they are only represented through the inclusion of the Requirements Officer (a full-time user representative). While in theory this affords a means for users to play a detailed role in equipment development, there are a number of disadvantages of this user representative strategy such as the hostage effect, limited representation of rank, limited representation of user areas, lack of continuity of staff and the potentially biased viewpoint of user representatives.

In order to counter the problems associated with full-time user representation, it is necessary to consider ways which may increase user involvement and improve user representation in the development and acquisition process. Ideally, this will mark the beginning of an evolutionary process towards a more user-centered design strategy tailored to the particular requirements of the CF. Two differing approaches are being examined at DCIEM to accomplish this goal. The first focuses on allowing part-time user representatives to develop a profile of themselves, the second centers around a more rigid management of HFE procedures.

One of the problems with much of the development and acquisition process, is that it emphasizes technical areas and pays little or no attention to issues of context. Designers need to know the context in which their system or equipment will be employed. This is particularly true of personal equipment. Few designers of advanced systems have detailed knowledge of operational conditions and constraints. One development (the Soldier's Day) being undertaken for the Canadian Forces is aimed at providing designers with the context of the roles and tasks that operators perform, as an aid to understanding how equipment will be used.

INTRODUCTION

In the development of military systems, users needs are addressed through the application of human factors engineering (HFE). In the Canadian Forces (CF), HFE is a recommended rather than a required activity[1]. The Department of National Defence (DND) guide to project management recommends (DND, 1988) that project managers ensure that the contractor apply two US Department of Defense documents which govern human engineering: MIL-H-46855B and MIL-STD-1472D. US MIL-H-46855B: *Human engineering requirements for military systems, equipment, and facilities* specifies the overall approach to HFE in military system development. The approach set out in MIL-STD-46855 emphasizes analysis starting from a stated operational requirement and includes activities related to design, experiments, tests, and trials. US MIL-STD 1472D *Human engineering design criteria for military systems, equipment, and facilities* provides human engineering design standards.

It has been recognized that the Department of National Defence (DND) development and acquisition process is 'cumbersome' and 'time consuming' (Auditor General, 1992). The process varies from project to project. The applicable military standards are rarely followed to the letter and may even be completely overlooked (Beevis & Hill, 1983). HFE is often considered to be intuitively obvious, and devoting effort and funds to HFE is frequently seen as a hindrance to the overall project development instead of being recognized as a key to ensuring a project's overall success. HFE issues are often not considered in the planning process until late in development, if at all, when a human factors related problem is identified. At this point, due to the constraints of the project, there may be little scope for change that is feasible or economical.

This paper advocates an earlier consideration of HFE issues than is currently employed. In particular, an early understanding of the users and their roles is urged as a key feature of the overall process.

SURVEY OF DEVELOPMENT AND ACQUISITION IN THE CF

In order to better understand how to integrate HFE issues into the overall acquisition process for personal clothing and equipment, a study was conducted to determine organizational attitudes to the inclusion of user requirements in DND development projects (Donati, 1994). The study consisted of participant observation and a questionnaire survey of persons responsible for representing users in project management positions (Director of Land Requirements (DLR), Director of Soldier Systems (DSSPM), Director Land Armaments and Electronics Engineering and Maintenance (DLAEEM)), or for applying HFE. The results of the questionnaire survey showed large differences in the attitude to, and application of, human factors issues (Donati, 1994) . As a result, there is often poor integration of HFE, as a whole, into the development and acquisition documentation; poor consultation with stakeholders; and negligible involvement of

[1] In contrast, US DoD instruction 5000.2 Part 6, Section H, requires that "design requirements shall be established to develop effective man-machine interfaces and preclude systems characteristics which: require complex cognitive, physical, or sensory skills; require complex manpower or training intensive tasks; or result in frequent or critical errors. ... Manpower, personnel, training, health hazard, and safety concerns will be translated into man-machine interface design issues to be addressed during systems engineering."

actual users in the development and acquisition process[2].

To gain a better understanding of personal equipment development and acquisition, data from the study were analyzed using Hierarchical Task Analysis (HTA). HTA is a process of "gathering relevant information about human requirements for operating systems, the human resources available for meeting these requirements and the constraints which must be observed in reaching solutions" (Shepherd, 1993). In HTA the analyst is prompted to determine conditions when various subtasks should be carried out in order to meet a system's goals. The product of the HTA is a hierarchy of operations (the different things that people must do within a system) and plans (statements of the conditions necessary to undertake these operations). As a result of the hierarchical nature of the description, the analysis can be developed in as little, or as much, detail as is needed to deal with a given task. The HTA can be presented either in the form of a table or in graphical form (see figure 1 for an example).

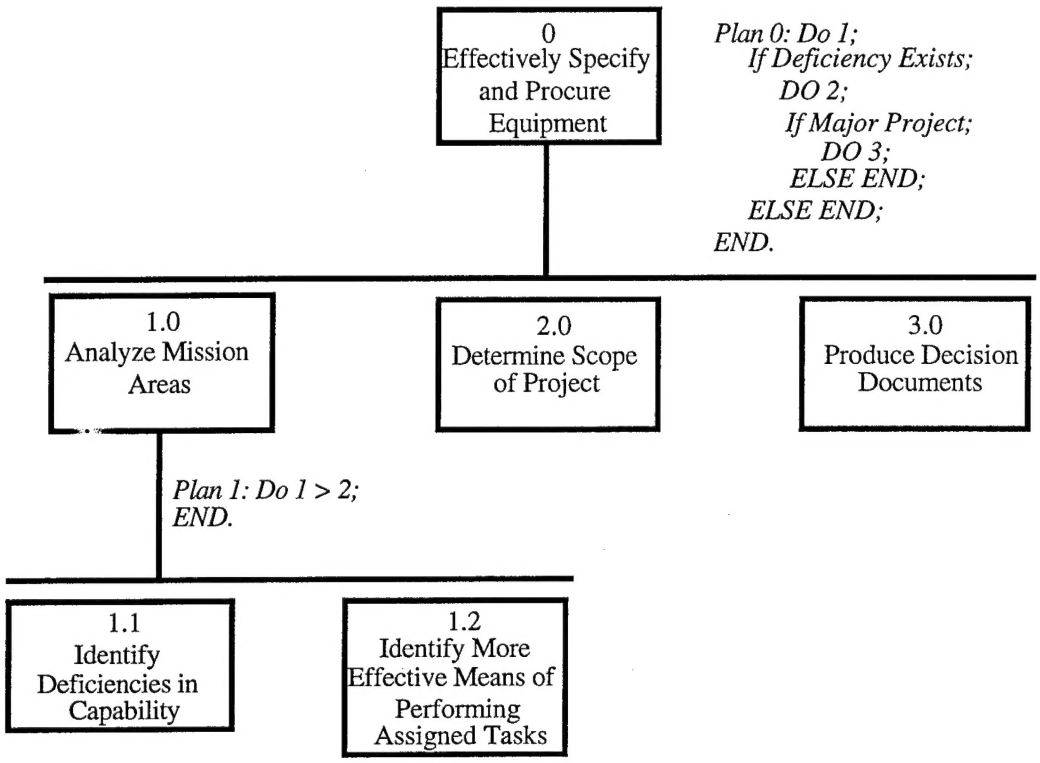


Figure 1. Example of a Portion of the Hierarchical Task Analysis (HTA).

This analysis began with stating the overall goal to be achieved : *Effictively Specify and Procure Equipment.* The goal was broken down (re described) into operations, and an associated plan stating when the operations are to be carried out. Examples of operations are: Analyze Mission Areas, Determine Scope of Project, Produce Decision Documents. An example of a plan is: Do operation 1 then operation 2 then end. When satisfactied that the re-description is

[2]The major major conclusions of the study were a need to identify relevant stakeholders, a need for increased user involvement, a need to improve communications channels between stakeholders, a need for improvements in trade-off analyses, and a need for improved consideration of implementation strategies.

adequate, a decision is made regarding whether or not to further break down operations into sub-operations. The stopping rules used were: a) that there was no apparent problems associated with a given operation; and b) that it was not necessary to break down the operation further to present a solution to an identified problem. If further re-description was necessary, it again involved the process of breaking the operation down into subordinate operations and an associated plan. In the example in Figure 1, the operation *Analyze Mission Areas* is further re-described into the following sub-operations: *Identify Deficiencies in Capabilities* and *Identify More Effective Means of Performing Assigned Tasks*.

THE NEED TO BRING HFE AND USERS INTO THE DESIGN PROCESS EARLIER

One clear conclusion from the HTA was that the personal equipment development process involves several activities which occur prior to the initial activities specified by MIL-STD-46855 (see Figure 2). This is apparent if the overall DND acquisition process is examined (Figure 3).

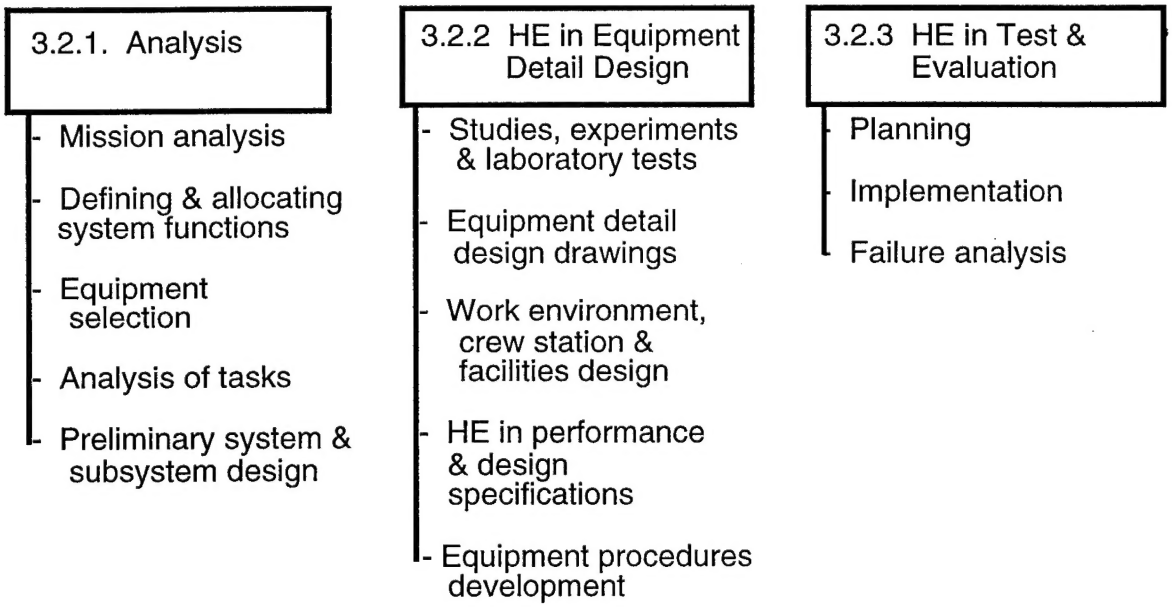


Figure 2. Human Factors Activities Specified by MIL-H-46855B

The acquisition or development process occurs in direct response to a requirement for a specified capability in the CF. Activities associated with the acquisition process commence with a Problem Analysis and conclude with the acceptance of the new or modified system. The first phase of Project Initiation concludes with the preparation of a Preliminary Statement of Requirements (SOR). The SOR is a document which describes an equipment item in terms of the operational needs, and which states the minimum essential performance requirements that the DND has determined necessary. Since the SOR is the initial step in a long process, it is critical that this document reflect the users' requirements and that the information contained within the document is presented to designers in a manner that is clear, complete, and can be validated (Shepherd and Ormerod, 1992).

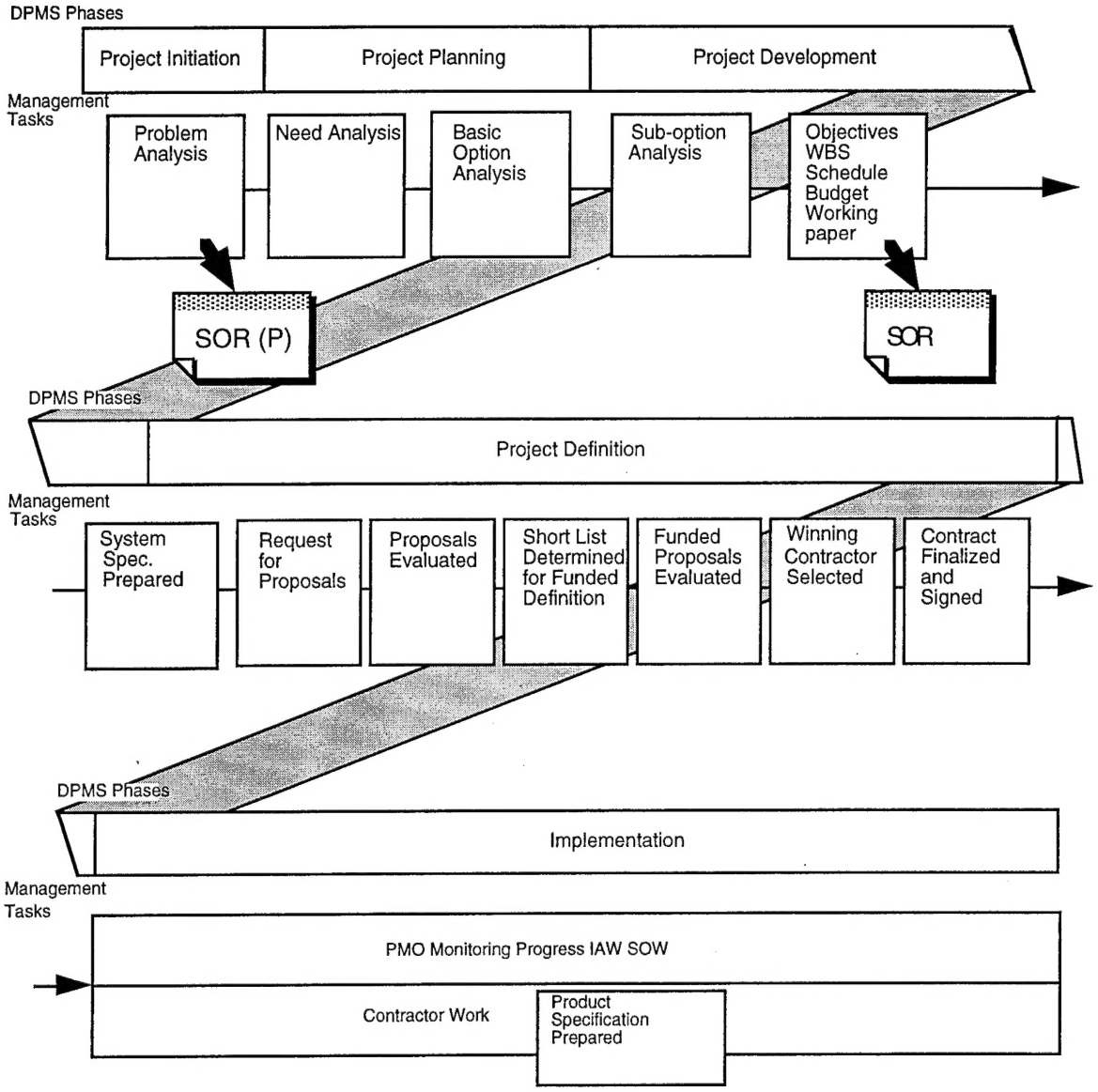


Figure 3: Defence Programme Management System Phases and Associated Management Tasks

Recent HFE literature suggests that requirements for new systems should be developed with users and stakeholders in an iterative manner (see Beevis, Essens & Mack, 1993). This implies a further broadening of the scope of requirements definition activities. Yet there are few guidelines available to help with this activity. There have been many attempts to develop tools to improve the application of HFE in the concept development and design phases of system development (Karkowski, Genaidy and Asfour, 1990, for example). In contrast, few tools have been identified for addressing user requirements at the outset of a development project (Eason, 1988).

USERS AND USER REPRESENTATION IN THE DESIGN PROCESS

As outlined above, the end users are key stakeholders in the development and acquisition process. Currently there are two major sources of user input into that process from the 'field': feedback concerning the limitations of current systems and equipment, and information from persons familiar with the users' needs.

Feedback From Users

There are two opportunities for equipment users in the field to relay information back to designers regarding equipment performance. The first is accomplished by filling out an Unsatisfactory Condition Report (UCR) and the second is indirectly through a safety report filed after an accident.

UCRs are available to all service people to complete when they feel a piece of equipment does not allow them to effectively perform their duties. The paperwork burden associated with filing a UCR however, can be daunting. The forms, which have to be duplicated locally, are time consuming to fill out. Further, approval and agreement must be granted from superiors as the paperwork moves towards its final destination. To complicate matters further, the UCR is transferred from the operational chain of command to the maintenance chain of command on its travels. The multiple levels of review and approval result in a time lag and also in a feeling of helplessness on the part of users. When combined with the attitude that "if it has been this way for the last twenty years and it was good enough for all those soldiers, it is good enough for you", there are many fewer UCRs submitted than might be expected. The lack of UCRs on any particular item does not necessarily reflect acceptance in the field. It has been known to occur that an item of equipment is put into service but is not routinely used in the field. As a result, there is little feedback, good or bad, about its performance. The lack of feedback leads to assumptions by headquarters that the equipment development and acquisition has been successful.

Users may have the opportunity of participating in the development and acquisition process if they are asked to become involved in the test and evaluation of new equipment items. Often however, the test and evaluation is conducted by a dedicated test and evaluation unit. This means that the majority of users are excluded from the process.

User Representatives And Their Impact

The Directorate of Land Requirements (DLR) represents the interests of field users of new systems and equipment. DLR personnel are former equipment users who are assigned to a staff position for a number of years. They are considered to be "operators" as they were previously equipment users, and are considered to be representative of current users. Their responsibilities center around the determination and elaboration of the equipment requirements of the Land Forces. In this role they are called Project Directors (PD). The primary product of their involvement in the acquisition/development cycle is the Statement of Requirements (SOR). The PD tends to have little or no formal training in HFE or in requirements specification writing. They are expected to learn on the job through practice and experience.

This lack of training is reflected in the attitude of PDs to user requirements. In the questionnaire survey, when asked who they collaborated with in developing the requirements for new systems and equipment, only HFE specialists mentioned collaborating with field users. In follow-up interviews, respondents confirmed that they felt that the user was adequately represented through the inclusion of the Requirements Officer.

While in theory the use of full-time user representatives affords a means for users to play a detailed role in equipment development, there are several disadvantages to this approach. These are discussed below.

Hostage Effect - The main disadvantage with the current form of user representation is that in taking an individual from the field, making him/her a staff officer, and then thrusting him/her into an administrative network, the individual soon becomes indoctrinated and socialized into the culture of the staff officer and ceases to be a true user. This individual may now become an excellent project administrator, but a poor user representative. Hedberg (1975) terms this the "hostage effect", where a user joins a design team composed of technical specialists on a full time basis, and before long, the individual has acquired not only the skills, but also the ambitions, values, and attributes of the other team members. Ideally, the user representative should be able to challenge the views of the rest of the team members in presenting the user's viewpoint. The user representative suffering from the hostage effect will not be able to. As a result there may be a negative or hostile reaction to the equipment when fielded because the field users have not been able to contribute their knowledge or ensure that issues that concern them have been adequately addressed.

Use of a user representative can result in the majority of users being excluded from the design process. Eason (1988) argues that if the hostage effect occurs, "the remainder of users tend to be consulted less than they might have been had there been no user representative". In a worse case scenario, the team may believe that they have all the 'user' knowledge they require in their immediate team. They may confuse the enthusiasm of the user representative for actual feedback from users in the field and not consult widely with the user community. This could lead to serious disappointment when late in a project it is realized that the equipment users in the field have a very different idea of what they want.

Limited representation of rank - User representatives tend to be senior officers (rank of Major). This is appropriate for staff responsibilities and for discussions of strategic nature where an appreciation of the implications of a potential system is needed. A senior rank may also be advantageous for fostering debate amongst colleagues and mustering the resources required to pursue the study of the implications of a proposed system. Using a senior staff member as part of a design team however, may not be as useful. Staff officers are removed from the day-to-day operations in the field and may not be aware of the significance of many design decisions. If a user representative is to be used, the person should be one with considerable experience in "field" operations and one who can point out limitations of design options.

Limited representation of user areas - User representatives should be chosen from the various user areas to be affected by the new equipment. Clearly, this points back to the need for a clear and complete Stakeholder Analysis.

Lack of continuity of staffing - User representatives are rotated. The CF attempts to provide its staff with a range of work experience. One of the positions that an officer can occupy is that of user representative, or requirements officer. Rotation can be positive in that it can counter the "hostage" effect. However, the negative aspects far outweigh the positive. It takes a great deal of time for an individual to become a competent user representative, familiar with the bureaucracy of the development and acquisition process. Rotation results in removal of these resources just as they are about to pay dividends. Further, both formal and informal channels of communications can be built up by these individuals, for instance ties whereby information about user needs is transmitted, and rotation often results in the breakdown of these channels. As a result, it appears best to go for continuity on position and role if possible.

Biased viewpoint of user representatives - User representatives are required to provide

information on the users to other members of the design team. This can reinforce the perception that they truly represent the users. Cases have even occurred where the requirements personnel consider themselves to represent field users to the point of their being physically the same, so that mockups and prototypes are judged on the criteria that "I have normal hands (or seated eye height, or reach etc.) and I can use the equipment, so it is acceptable."

POSSIBLE SOLUTIONS

The various problems associated with the current user representative strategy point to the need for a more user-centered approach to the development and acquisition process. Unfortunately, given the other organizational priorities of the Department at the present, it is not likely that a shift to a user-centered approach will take place in the short term. It is necessary therefore to consider ways which may increase user involvement and improve the representation of users in the development and acquisition process. Two approaches are being examined at DCIEM to accomplish this goal. The first focuses on allowing part-time user representatives to develop a profile of themselves, the second centers around a more rigid management of HFE procedures.

Increase User Specification Through Increased User Involvement And Representation

It is not possible for every stakeholder in a development and acquisition project to be involved in every decision. Strategic decisions are best left to staff officers, while decisions regarding user needs are best left to the users themselves. At present, there is no avenue for field users to participate in the process. There is a need for a means of managing the project, handling all the requisite interaction between stakeholders, and yet not allowing the process to degenerate into the chaos represented by statements such as "you ask ten users for their opinion and you will get eleven replies."

To allow the views and requirements of users to permeate acquisition projects, use could be made of part-time user representatives taken directly from the "field" who continue to operate within that context. The part-time user representative could in effect become the advocates of user requirements and could be involved directly in the evaluation of alternative design solutions against user requirements. The intent of this approach is to allow users to become actively involved in specifying themselves and their characteristics. In essence, this empowers users, through the part-time "field-based" user representatives, to "sign-off" at various stages in the design process.

The use of part-time user representatives in this manner necessitates the establishment of a forum for them to present their feedback to the project. Such a forum could take the form of a Project Review Meeting, where a list of CF acquisition projects could be considered. This would allow the user representatives to be involved in more than one project at a time, and would afford them the awareness of the problems associated with the interface between projects (i.e.. compatibility, usability etc.). A user representative empowered to consider all new equipment items and their interaction in unison would be more effective in such a role than a compartmentalized senior manager.

One means of mediating this process, is through the use of a series of matrices that build upon each other. An example of such a matrix which incorporates design team constraints, user roles, user characteristics and equipment functions is presented in Figure 4. Interacting factors are identified with a check mark and examined in further detail. By examining these factors it is possible to ensure that there is a match between the expected equipment functionality and the

user tasks and characteristics as defined by the development and acquisition team in conjunction with users.

	ballistic protection	impact protection	comfort	para-dropable	communications capable									
Design Constraints														
time														
cost														
resources														
Task Characteristics														
Move by Foot														
move on open terrain														
move through obstacles														
move through buildings														
Move by Vehicle														
Move by Aircraft														
User Characteristics														
age														
strength and stamina														
body size														
Assessment														

Figure 4. Users/Tasks/Equipment Functionality Matrix.

In filling out the matrices, there are a number of user characteristics which can be defined in the form of a person specification. The person specification contributes much of the background information needed to clearly specify user constraints to the design team. Examples of factors which can be detailed in this manner are user anthropometrics, user strength and stamina, and user gender.

Increase User Specification Through More Structured Approach to Documentation

A review of ten major projects of the Canadian Department of Defence (DND) reached several conclusions relevant to the application of HFE in the systems design and development process (Beevis, 1987). The review noted that a coordinating committee with representatives from operators, engineering specialties, and human factors engineering had been very effective in articulating and managing the customer's approach to design requirements involving human factors issues. The review also concluded that the application of HFE appeared to be facilitated by the preparation of a Human Engineering Project Plan (HEPP). Those projects that had used a Human Engineering Project Plan had involved a wider scope of HFE activities than those that had not used such a plan. Human Engineering Project Plans are prepared by the contractors at the outset of a project to define the scope of the human factors engineering effort. Typically, the HEPP is specified by US DoD DI-HFAC-80740 and based on US MIL-STD-46855.

The HEPP forces the systems developers and the procuring agency to agree on what will be done to design for the users of the system or equipment. One possible reason for the effectiveness of the HEPP is that it compensates for the lack of HFE activities in the work breakdown structures (WBS) typically used for military systems (MIL-STD-881B: *Work Breakdown Structure for Defense Materiel Items*, 25 March 1993). Examination of that standard shows that no single item can be associated with human factors engineering in any of the exemplar military systems which are addressed by the standard. Thus no one item in the WBS can be associated with human factors engineering. Instead, responsibilities for HFE are distributed across many items of the WBS.

A comprehensive HEPP will address HFE activities starting with the drafting of a system specification and ending with test and evaluation. The DND document governing specification preparation (D-01-300-100/SG-000, 1 August 1979) permits the inclusion of 'Technical and mission requirements for the complete system;' 'Interfaces between functional areas and other systems;' and 'Performance characteristics.' Each of these topics could be used to address HFE or user requirements such as the need for equipment to be operable by a specified range of CF personnel, with specified training and experience, in specified conditions. The ideal would be to follow the US Army's Manpower Integration (MANPRINT) Program in providing the basis for answering the question:

> "Can *this soldier* , with *this training*, perform *these tasks*, to *these standards* , under *these conditions?*.

US MIL-STD 490A *Specification Practices* provides a more thorough basis for specifying user requirements. Para 4.3.3.7 of that standard states that "Human engineering requirements ... should be specified herein ... This paragraph should also specify any special or unique requirements, e.g., constraints on allocation of functions to personnel, and communications and personnel/equipment interactions. Included, should be those specified areas, stations, or equipment that require concentrated human engineering attention due to the sensitivity of the operation or criticality of the task, i.e., those areas where the effects of human error would be particularly serious." This provides an opportunity to describe the users and their operations as they affect the performance of the system. Similarly, paragraph 4.3.6. requires that "requirements imposed by or limited by personnel or training considerations shall be specified ...." thus providing an opportunity to specify the level of training which the operators will have prior to being training on the system.

The user requirements included in the specification must be reviewed as the design progresses or as part of the proposals for an off-the-shelf acquisition. US MIL-STD-1521 B (USAF) *Technical reviews and audits for systems, equipments, and computer software* includes

provision for reviewing the following:

a. as part of the System Requirements Review
   (1) human factors analysis; and
   (2) manpower requirements/personnel analysis; and

b. as part of the System Design Review
   (1) human factors; and
   (2) training and training support ; and

c. as part of the Preliminary Design Review and the Critical Design Review
   (1) mock-ups, models, breadboards, or prototype hardware; and
   (2) human engineering and biomedical considerations.

For test and evaluation purposes, MIL-H-46855B requires that "Human engineering test planning shall be directed toward verifying that the system can be operated, maintained, supported and controlled by user personnel in its intended operational environment. Human engineering test planning should also consider data needed or to be provided by operational test and evaluation. Test planning shall include methods of testing (e.g., use of checklists, data sheets, test participant descriptors, questionnaires, operating procedures, and test procedures), schedules, quantitative measures, test criteria and reporting processes." Compliance with this requirement would necessitate user input to describe the test participants, and agree to the test criteria.

Overall, then, existing documentation provides the framework for a much improved approach to specifying user requirements in CF acquisition projects. One of the problems with much of the development and acquisition process as a whole, is that it emphasizes technical areas and pays little or no attention to the context in which the equipment will be used. As an example, when an SOR is passed to an advisory agency, say DCIEM, it is usually circulated amongst subject matter experts to ensure that all relevant HFE issues have been considered. This is often done against severe time constraints due the last minute need to include human factors in the process. Since there is little context provided, inputs tend to be generic catch-all phrases (e.g. "the equipment item must be compatible with all CF vehicles.")

The problem inherent in this process can be further illustrated in the example of the operational need that a 105 mm Howitzer Field Gun be "accurate". Accuracy from a human factors engineering perspective is quite different from that of the engineering discipline. The strict engineering interpretation of accuracy is based on quasi-laboratory test with the gun thoroughly supported or "bedded in", carefully calibrated, and operators taking plenty of time to aim (Human*Systems*, 1991). This particular weapon system may prove very accurate in the lab test as it is well bedded down and carefully fired. The same equipment may be very inaccurate when fired by soldiers who must operate the weapon in a much wider operational context. The bottom line from the human factors engineering perspective is the level of accuracy which can be achieved in the field under normal operational circumstances.

Clearly, all the stakeholders in the development and acquisition process need to know the context in which the equipment will be used. This is particularly true of personal equipment. Few designers of advanced systems have the opportunity to observe how they are used in practice. One development being undertaken for the Canadian Forces is aimed at providing all participants in the development and acquisition process with the context of the roles and tasks that operators perform, as an aid to understanding how their equipment will be used.

THE SOLDIERS DAY

The Soldier's Day multimedia database is being developed (through a contract with Human*Systems* Incorporated of Guelph, Ontario) as part of an initiative to provide baseline data to requirements officers, engineering agencies, research establishments and contractors. Users within these groups were surveyed to determine their information needs. These needs were situated within the four major categories: clothing and equipment, organization and the soldier, and roles/tasks and activities, and Human Factors related information (at the moment, human factors information is restricted to references). The database has been structured around these four data streams and this is highlighted in Figure 4, the opening screen from the database.

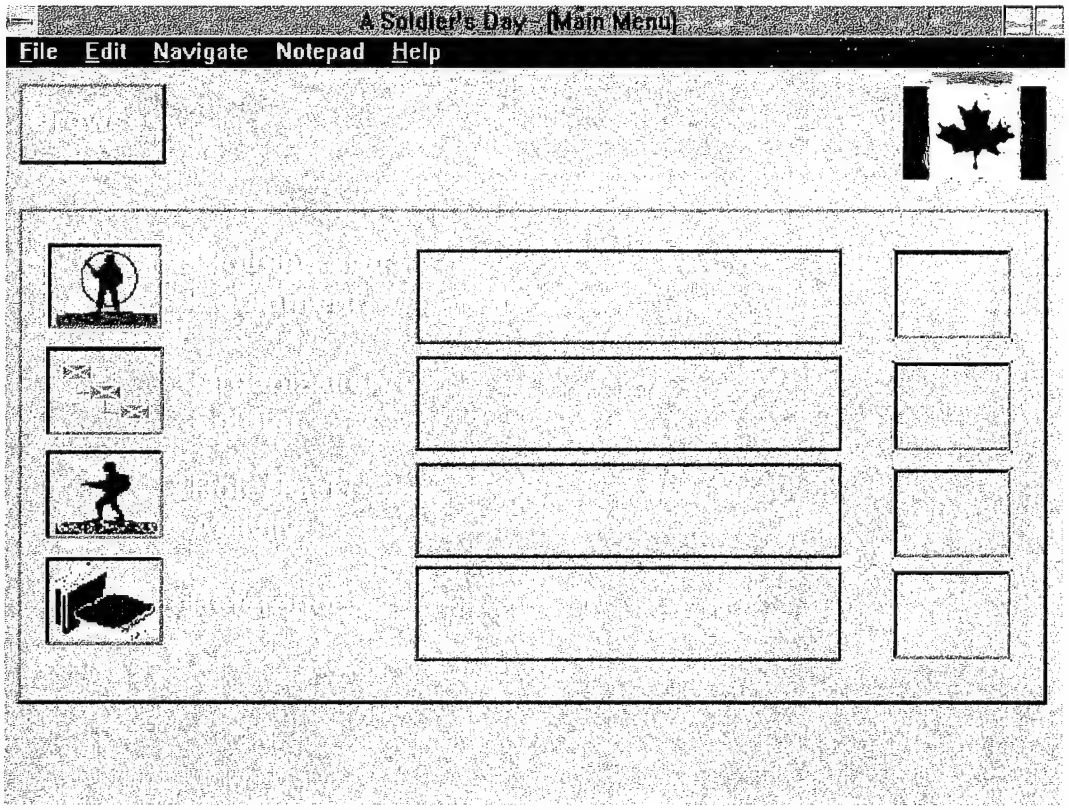


Figure 4. Soldier's Day Database Opening Screen showing the structure of the database.

The information available in the Soldiers Day database supplements the information required in order to specify users and their roles. By feeding the information from the Soldier's Day into the matrices discussed above, a common context-rich frame of reference should be established for both users and development and acquisition participants. Each data stream and its associated data items and use is discussed below through the use of screen shots.

Clothing and equipment

Figure 5 is a screen shot depicting the main database interface, in this case for the clothing and equipment data stream. In this example, the user is accessing information on the 1982 pattern webbing. The upper left hand window is used to display audio visual information in the form of photographs, videos, and schematics/graphics. The right hand window is used to display textual information. This information may take the form of general equipment item descriptions, more detailed technical descriptions, training material etc. Associated equipment items (component parts) and the items which interact with the selected equipment items (compatibility) can be accessed from the 'Item and Associated Equipment' dialogue box. A link to associated items in the organizational or activity data streams can also be made by selecting the appropriate radio button on the left hand side of the screen. This encourages the user to explore links with the other data streams. For example, by selecting *Associated Soldiers*, the user can transition to the organization/soldier data stream and can examine who wears webbing. By transitioning to the I data stream, the user can explore under what conditions the equipment will be employed.

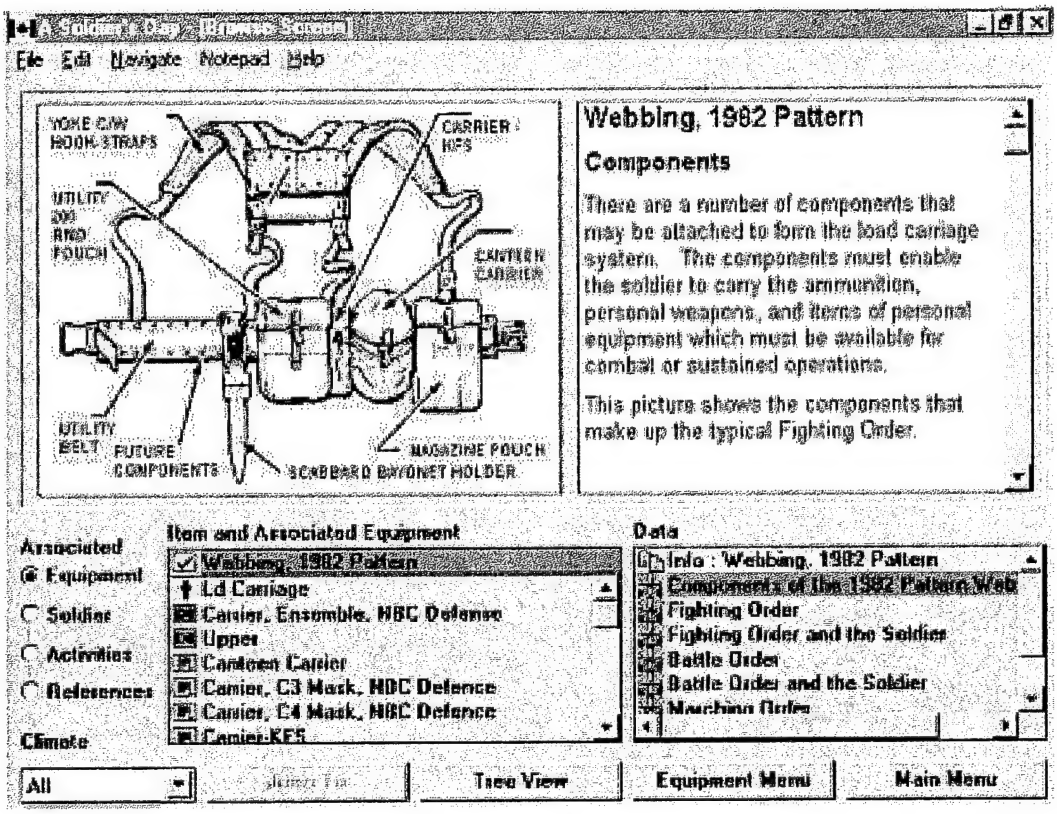


Figure 5. The Soldier's Day database interface for the Clothing and Equipment data stream.

Organizational Structure

The organizational data stream contains general information on the organization of

soldiers. By following a hierarchical schematic, one can examine various levels of organization and retrieve general knowledge about these. The Soldier's Day database focuses in detail on the rifleman, the lowest level in the hierarchy. In the example screen shot, (Figure 6) the user is accessing information about rifleman demographics, in this case, weapons use. The user also has the capability to move upwards to examine higher levels of organization or to examine associated equipment, activities or references.

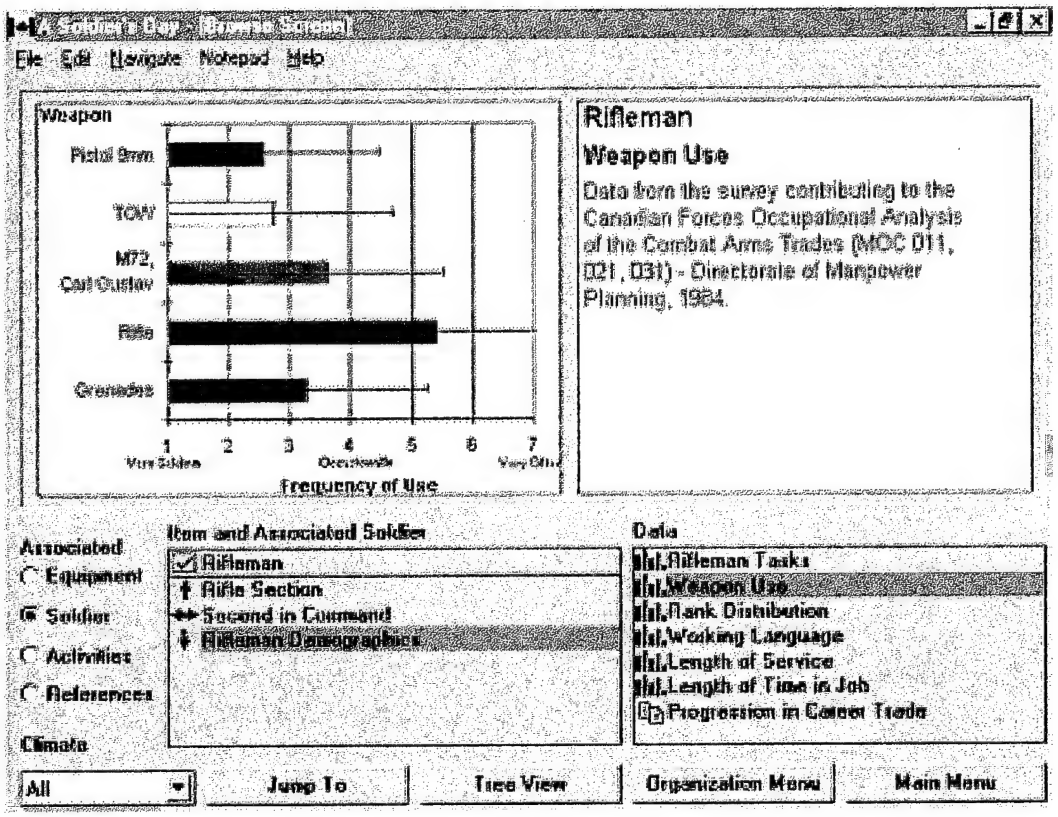


Figure 6. Screen shot of the Organization data stream focusing in on Rifleman weapons use.

Operations

The operations data stream contains information on soldier Roles, Tasks and Activities. The user is encouraged to explore a hierarchical breakdown of soldier Tasks and Activities in order to better understand how equipment will be used. Figure 7 is a representative screen shot for the activities data stream. Here the user is accessing information on C7 Rifle Firing in the prone position. Photographs and videos are provided to allow the user to explore how the C7 rifle is employed and under what conditions. Related activities or higher order tasks and roles can also be examined. Linkages can be made between this and the other data streams.

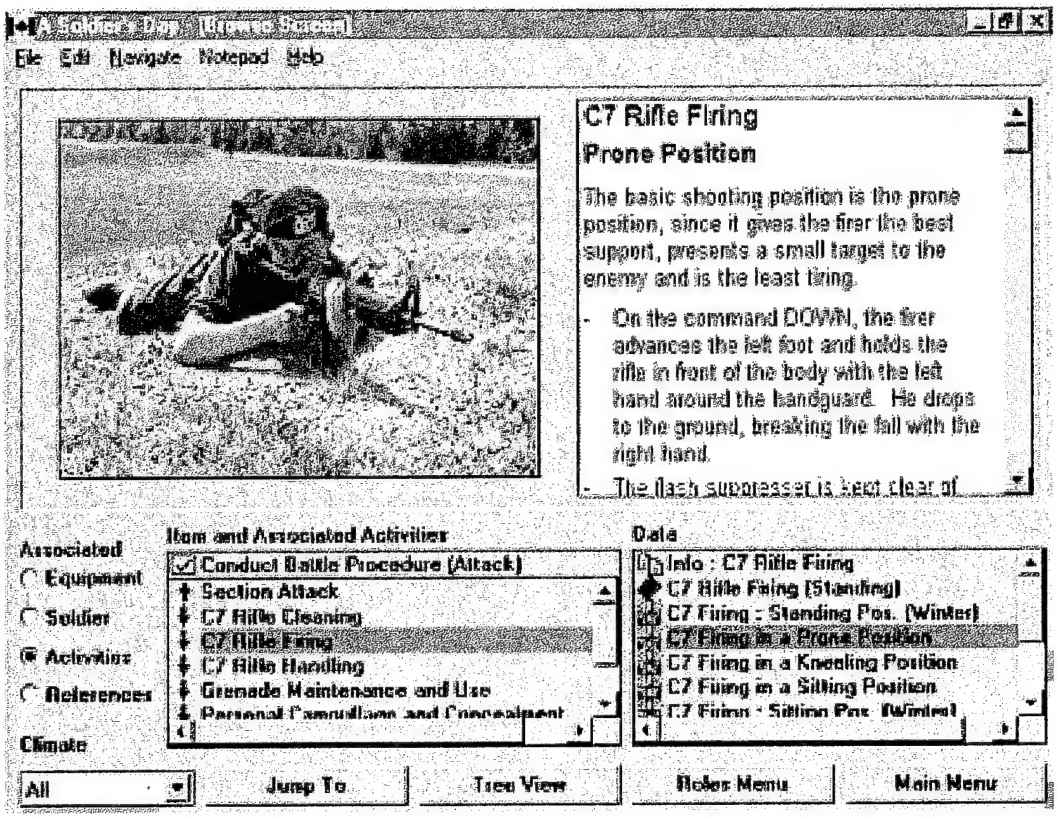


Figure 7. Screen shot of the Roles/Tasks/Activites data stream focussing on C7 Rifle Firing.

CONCLUSIONS

There is a need to move towards a more user-centered approach to the design of personal equipment. There is room for improvement of the full-time user representative strategy currently being used. Existing regulatory documents provide the framework for a much-improved application of user requirements in the acquisition process. User representation and involvement can be improved by the introduction of part-time user representatives into the process. Matrices can be used to identify target users, assist in the preliminary specification of an equipment item's functionality, and ensure that user tasks, user characteristics and equipment functionality are matched to one another. It is hoped that in the interim, while a more user-centered approach is being developed, the Soldier's Day database will foster an improved understanding of user roles and tasks. A heightened focus on the specification of users and their roles will enhance the systems development process and so result in better products produced for users in the field.

REFERENCES

Annett, J., Duncan, K.D., Stammers, R.B. and Gray, M.J. 1971. *Task Analysis*, Training Instruction Paper No. 6, London, H.M.S.O.

Auditor General. 1992. Report of Auditor General of Canada to the House of Commons. Government of Canada. Chapter 17.

Beevis, D. and Hill, M. 1983, The Designer as the Limiting Human Factor in Military Systems, in *The Human as a Limiting Element in Military Systems* Volume 1 (NATO Defence Research Group Proceedings)

Beevis, D. 1987, Experience of the integration of human engineering effort with avionics systems development, in *The Design, Development and Testing of Complex Avionics Systems,* (AGARD Conference Proceedings No. 417) (Advisory Group for Aerospace Research and Development, Neuilly sur Seine, France), 27-1 - 27-9.

Beevis, D., Essens, P. and Mack, I. (eds.) 1993, The Application of Human Engineering in the Development of Command and Control Information Systems for the Canadian Forces: Proceedings of a Workshop held in Richmond (B.C), July 8-9, Report No. 93-42, DCIEM, Toronto.

Eason, K. 1988. *Information Technology and Organizational Change.* London: Taylor and Francis.

Department of National Defence, 1988. Project Management, Volume 6, Chapter 30: System Engineering, Annex A. Ottawa: Department of National Defence.

Donati, L. 1994. Enhancing Human Factors Engineering in the Development and Acquisition of Personal Equipment in the Canadian Forces. M.Sc. Thesis, Loughborough University of Technology.

DI-DFAC-80740. 1987. Human engineering program plan. Washington D.C.: Department of Defense. (March).

Hedberg, B. 1975. Computer systems to support industrial democracy. In Mumford, E. and Sackman, H. (eds), *Human Choice and Computers.* North-Holand, Amsterdam

Human*Systems* Inc. 1991. *Human Engineering Evaluation of the C3 and C1-105mm HOWITZER.* DCIEM Contractors Report - Contract No. W877-9-CB17/01-XSE.

Karkowski, W., Genaidy, A.M., and Asfour, S. (eds), 1990. *Computer-Aided Ergonomics.* Taylor and Francis, London.

Kirwan B. and Ainsworth, L.K. 1992, *A Guide to Task Analysis* Taylor & Francis, London.

MIL-STD-881B .1993. Work breakdown structures for defense materiel items. Washington D.C.: Department of Defense. (25 March).

MIL-H-46855B. 1972. Human engineering requirements for military systems, equipment, and facilities. Washington D.C.: US Army Missile R&D Command. (31 January).

Shepherd, A. 1976. An improved tabular format for task analysis. *Journal of Occupational Psychology*, 49, 93-104.

Shepherd, A. 1993. *Occupational Tasks and Skills - Documentation and Training.* Course manual, Loughborough University of Technology.

Shepherd, A and Ormerod, T.C. 1992. *Development of a Formal Method of User Requirements Specification for Process Plant Displays.* Research Report for British Gas, Loughborough University of Technology.

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (the name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g., Establishment sponsoring a contractor's report, or tasking agency, are entered in section 12.)	2. DOCUMENT SECURITY CLASSIFICATION (overall security classification of the document including special warning terms if applicable)
DEFENCE AND CIVIL INSTITUTE OF ENVIRONMENTAL MEDICINE	UNCLASSIFIED

3. DOCUMENT TITLE (the complete document title as indicated on the title page. Its classification should be indicated be the appropriate abbreviation (S,C,R or U) in parentheses after the title.)

THE SPECIFICATION OF USERS AND THEIR ROLES

4. DESCRIPTIVE NOTES (the category of the document, e.g., technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

5. AUTHOR(S) (Last name, first name, middle initial. If military, show rank, e.g. Burns, Maj. Frank E.)

CAPTAIN DONATI, LEO AND BEEVIS, DAVID

6. DOCUMENT DATE (month and year of publication of document)	7.a. NO. OF PAGES (total containing information. Include Annexes, Appendices, etc.)	7.b. NO. OF REFS. (total cited in document)
October 95	15	18

8.a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant)	8.b. CONTRACT NO. (if appropriate, the applicable number under which the document was written)

9.a. ORIGINATOR'S DOCUMENT NUMBER (the official document number by which the document is identified by the originating activity. This number must be unique to this document.)	9.b. OTHER DOCUMENT NO.(S) (any other numbers which may be assigned this document either by the originator or by the sponsor.)

10. DOCUMENT AVAILABILITY (any limitation on further dissemination of the document, other than those imposed by security classification)

X	Unlimited distribution
	Distribution limited to defence departments and defence contractors; further distribution only as approved
	Distribution limited to defence departments and Canadian defence contractors; further distribution only as approved
	Distribution limited to government departments and agencies; further distribution only as approved
	Distribution limited to defence departments; further distribution only as approved
	Other

11. ANNOUNCEMENT AVAILABILITY (any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (10.) However, where further distribution (beyond the audience specified in 10) is possible, a wider announcement audience may be selected.)

12. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include the address.)

DCIEM

DSIS DCD03
HFD 09/94

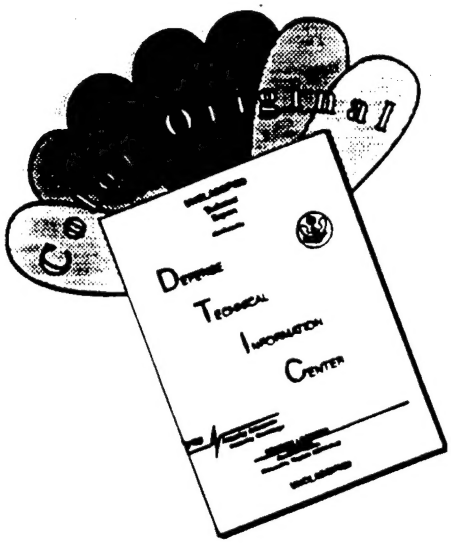
13. ABSTRACT (a brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual).

Although the approach to systems development varies widely, the overall approach to human factors engineering i military system development is usually specified by US MIL-STD-46855. The approach set out in 46855 emphasize analysis and reflects the traditional waterfall model of systems development, although there is nothing inherent in th standard to prevent an iterative approach. A review of ten Canadian Forces development projects concluded that th application of human factors engineering, was enhanced by the use of a Human Engineering Project Plan based o MIL-STD-46855. A subsequent survey of approaches used to include user requirements in development projec showed large differences in attitude and practice. The survey identified the need for aids to facilitate the inclusion o users' requirements in the Statements of Requirements, produced at the initial stage of procurement. Designers als need to know the context in which their system or equipment will be used. This is particularly true of persona equipment. Few designers of advanced systems have the opportunity to observe how they are used in practice. On development being undertaken for the Canadian Forces is aimed at providing designers with the context of the role and tasks that operators perform, as an aid to understanding how their equipment will be used.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible, keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

USER INVOLVEMENT, USER REPRESENTATION, USER ROLES, HUMAN FACTORS ENGINEERING

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF COLOR PAGES WHICH DO NOT REPRODUCE LEGIBLY ON BLACK AND WHITE MICROFICHE.